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ABSTRACT

This review of the current status of the human information processing model presents the Stahl Perceptual Information Processing and Operations Model (SPInPrOM) as a model of how thinking, memory, and the processing of information take place within the individual learner. A related system, the Domain of Cognition, is presented as an alternative to Bloom's Taxonomy; it is designed as a system for identifying the sequence of thinking and processing likely to result in several different levels of learned behavior. A sequence of 21 uniproccesses, or mental operations, which an individual may use at these different levels is also presented. The implications of the SPInPrOM model and the Domain of Cognition system for instructional design are considered, and specific examples of their use in a new instructional design framework are presented. Three figures and bibliographic Hes are provided. (76 references) (EW)

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Chapter 13

Cognitive Theory within the Framework of an Information Processing Model and Learning Hierarchy: Viable Alternative to the Bloom-Mager System

Robert J. Stahl

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What do we know about human learning? Is the research literature on human learning now rich enough to support an alternative to Bloom's 1956 Taxonomy of Educational Objectives? The contention of this chapter is that we know far more about how learning takes place now than we did 25 years ago and that techniques and concepts which were acceptable at that time are no longer valid. The Stahl Perceptual Information Processing and Operations Model is proposed as a model of how thinking, memory, and the processing of information takes place within an individual. The Domain of Cognition is introduced as a system for identifying the sequence of thinking and processing likely to result in several different levels of learning.

Bloom's Taxonomy (Bloom et al., 1956) has dominated instructional design and evaluation for a quarter of a century. Programs at all levels of education use this Taxonomy as the major framework for planning, developing, implementing, monitoring, and evaluating instructional variables, both process and product, for both teachers and students. The popularity of this hierarchical model is evidenced by the entry of nearly 1,000 articles on the Taxonomy of Educational Objectives in Education Index between 1966-1978 (Clements, 1979). Furthermore, some teacher educators have even taught the Bloom System as a learning theory in its own right, giving the Taxonomy a status it was never intended to have.

Interestingly, the Bloom taxonomic system has been and is being used even though it is not consistent with any presently accepted theory, model, or approach to human memory, thinking, or learning (Stahl, 1979). Clements (1979) pointed out that three of the four major principles upon which the system was originally based were never supported by research. These initial problems have proved to be but the beginnings in the demonstration of weaknesses in the structure, levels, and sequence of the Taxonomy (Kropp and Stoker, 1966; Miller, Snowman and O'Hara, 1979; Smith, 1968, 1970; Poole, 1971, 1972; Seddon, 1978).

The intent of this chapter is not to provide a review of the literature concerning Bloom's Taxonomy. Instead, the reader will be introduced to an entirely new taxonomy, the Domain of Cognition, which was developed from the research literature on human learning. To support this hierarchical system, a model of how humans process information will be presented which forms a framework within which the synthesis of research in memory and learning can be considered and which provides a description of the flow of thinking, memory and learning as these occur interactively within instructional settings.

A by-product of using these two models was the development of a new set of criterion for writing specific instructional objectives. The specifications for writing these objectives are different from those proposed by Mager (1962). Following the presentation of the Domain of Cognition is an overview of a systematic approach to the identific-

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ation, selection, and writing of specific objectives congruent with the approach to planning suggested by Stahl (1978).

INTRODUCTION TO THE MODELS

The Bloom-Krathwohl taxonomic domains were important contributions to all areas of education in that they provided a much-needed framework for considering learning outcomes. However, today the results of research on thinking, memory, and learning suggest that an entirely new frame of reference is needed for identifying and accurately classifying learning outcome behaviors.

Instructional design in the 1980s must be tied to a taxonomic model which is directly compatible with the results of learning research conducted on human subjects. The new Taxonomy would be more useful if accompanied by a model of how individuals process information, one which has the strong support of extensive research findings. This model should have the additional attributes of being content-free and unrelated to the structure of any discipline. They should also be compatible with such divergent learning theories as those proposed by the "Behavioral," "Developmental," "Cognitive," "Perceptual," and "Gestalt" schools of psychological thought.

Besides the obvious benefits related to the measurement of learning, the new information processing-taxonomy model would have advantages for teacher educators. They would allow teacher-educators to help pre-service and in-service teachers make sense out of the various learning theories presented in the literature. This is especially true for teachers who have been introduced to different models of learning which appear to be inconsistent with one another and which are incongruent with the Bloom taxonomic system, which these teachers have been expected to use for planning and evaluating instruction. Such a model would also help teachers to develop instructional strategies which would be likely to aid students in attaining the different levels of learning which have been established as their end goals.

To summarize, what is needed in the field of instructional design is:

a) a model or explanation of how information is accepted, treated, processed, and acted upon within the individual learner. Such a model must be consistent with research findings in which human subjects were used and would distinguish among thinking, memory and learning as separate yet interrelated aspects of human behavior;

b) a model (taxonomy) explaining the different types or levels of memory, thinking, and learning which is consistent with the information processing model cited above and which stands upon its own merits with sufficient research support;

c) a way of helping pre-service and in-service teachers separate pre- and post-learning behaviors within classroom situations;

d) a way of looking at memory, thinking, and learning which "makes sense" to teacher-educators and teachers and is compatible with an extensive body of literature related to human learning; and

e) a way of converting the internal operations of thinking, memory, and learning into observable process (i.e., in-class) and produce (i.e., outcome) behaviors (Stahl, 1980).

A system incorporating the points above would be worthwhile and practical from the perspective of the teacher-educator and of the pre-service and in-service teacher. Such a system is the Stahl Perceptual Information Processing and Operations Model (SPInPrOM).

THE STAHL PERCEPTUAL INFORMATION PROCESSING AND OPERATIONS MODEL (SPInPrOM)

The basic components and flow of the SPInPrOM model are provided in Figure 13-1. The features and characteristics of the operation of this model are explained below. The SPInPrOM model contains some components featured in existing information processing models. The explanation suggests a workable sequence for how this information processing model operates in determining what and how thinking and learning take place.

The order of the presentation below is based upon convenience and ease of understanding. As appropriate, additional items will be identified for comprehensiveness, completeness and readability. The intent of this description is to explain the ways in which an individual goes about thinking which may result in learning.

1. **Environmental Information.** The Environmental Information component serves to identify the external source of information to be confronted and handled by a person's processing system. This component is defined to include all the information and stimuli which are available within the life space of the individual. As stimuli, environmental factors vary in their power, direction, intensity, and strength. Some of these factors may influence or dominate the person's thinking and behavior. The individual ultimately decides which elements of the environment will be attended to, internalized, and processed.

2. **Preparation or Perceptual Set.** Although this aspect of information processing is not identified by any single component of the model, preparation plays an important role in the early stages of the entire processing operation. Sometimes referred to as "expectancy set," this mind set exerts considerable influence on how the learner attends to, receives, processes, and understands available and recently received information

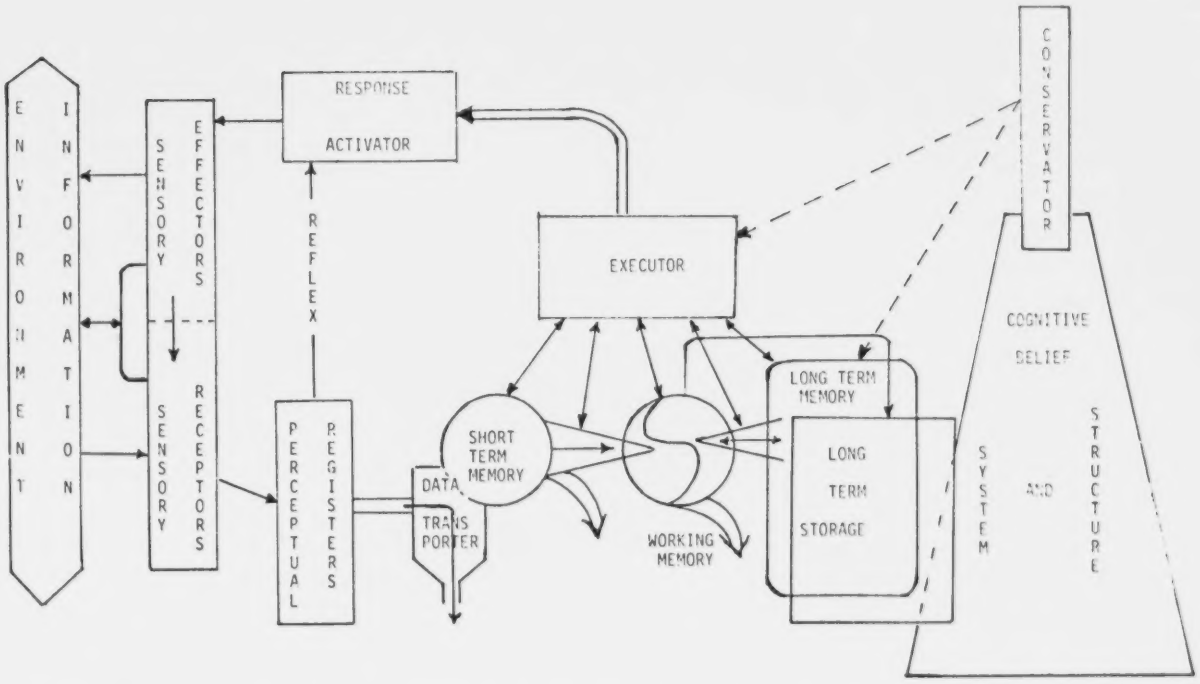

Figure 13-1. A diagram of the components, operations, and flow of activity within the Stahl Perceptual Processing and Operations Model—SPInPrOM (Copyright, Robert J. Stahl, 1979).

(Estes, 1972; Frase, 1977; Gagne and Rothkopf, 1975). A specific mind-set may or may not persist during an entire learning activity.

"Readiness," or preparation for information, plays a critical role in learning (Bloom, 1968; Ausubel, 1960; Neisser, 1976). In most situations the learner's personal motivations, learnings, and needs produce a powerful perceptual set (Gagne, 1976). These motivations prepare learners to expect certain environmental events and to view such events in ways consistent with their own motives and needs. At the same time, certain types of information (e.g., pre-and adjunct questions, advanced organizers) often alert learners to attend to, receive, process, and assign special meaning to about-to-be-presented information (Ausubel, 1960; Rothkopf and Bisbicos, 1967). This information suggests a "feed forward" feature of one's mind or perceptual set which acts in ways seemingly parallel to motivation-produced mind set.

3. **Sensory Receptors - Effectors.** Information in the environment is picked up by the individual's Sensory Receptors. These receptors include the physiological elements of the sensory system, including the organs and nerve networks of sight, sound, taste, smell, touch, as well as those physiological networks involved in the production of such internal phenomena as muscle pain, fatigue, and aches. Sensory Receptors pick up information from the environment and convert it into nerve impulses. Sensory Effectors, on the other hand, act upon the environment via internal response commands and are often identified with "selective attention" or "selective reception." For instance, the process of picking up and decoding sounds within the inner ear provides an example of Sensory Reception, the activity of directing the ear to deliberately "listen for" certain sounds in an example of a Sensory Effector at work.

This component of the model represents the interface points, where information from the environment is actually taken into (and by) the processing system. To be available for later processing, information must first be received.

4. **Perceptual Register.** The Perceptual Register picks up and momentarily records the kinds of information associated with an entire "perceptual system" rather than that which is picked up as independent perceptions by each of the individual sense organs (Gibson, 1966). For example, a total "aural perception" is recorded, rather than separate perceptions from each ear. Several "perceptual systems" exist and function within the body, and the Perceptual Register functions to integrate these into a total perceptual system.

The learner is capable of preserving the information (e.g., an image contained in the Per-

ceptual Register for a few milliseconds after the external information is no longer available to the Sensor Receptors. While the capacity of the Perceptual Register apparently is quite large, information is held by it for only a few milliseconds.

Information not placed in the Perceptual Register is no longer available for processing by the system. Further, a part of the information which has been placed in the Perceptual Register fails to survive those encoding operations which are necessary to translate it into a form which can be used by later stages in the information processing system. Hence, information can be lost at two points; information gathered by a perceptual system may never enter the Perceptual Register, and information within the Perceptual Register may never survive translation and transmittal to the next stages in the information processing system (the Data Transporter and the Short-Term Memory) (Haber, 1970).

Certain types of sensory information which reach the Perceptual Register are automatically converted into messages which activate an immediate behvavior response. Sensory data which require an immediate response (e.g., a hand on a hot stove) are identified as such during registration (i.e., reflex action required). A message is then immediately sent to the Response Activator, directing it to activate an appropriate "reflex" (i.e., pull the hand away).

5. **Data Transporter.** Information passing through this transporter mechanism must receive immediate attention or its specifics are quickly lost. In this component, information not attended to is presented and then rapidly "pushed out" within a few seconds. Information which is "pushed out" is lost to the memory and all later processing stages. However, information which is attended to may be preserved and remembered for longer periods of time. Unfortunately, the Data Transporter is often equated with Short-Term Memory rather than being seen as the data conveyor operation that it is.

6. **Data Surviving in the Data Transporter.** Information flowing through the Data Transporter will remain for a short period of time (i.e., a matter of seconds) and is then discharged (Baddeley, 1972). The processing system operates to instantly decide where this information is to go from here, and in what form. These decisions determine what will be retained verbatim, whether the "gist" of the message is enough to remember, and/or what other actions may be called for in dealing with the information. If the information is deemed meaningful in some way, a "memory trace" of the general "gist" of this information is produced within the Short-Term Memory. Unless motivated to do otherwise, the tendency of the system is to allow the specific details contained in this information to be lost (Berelson and Steiner, 1964).

7. **Short-Term Memory.** Short-Term Memory includes those aspects of recently received information which can be remembered. In contrast to the Data Transporter, which serves an extremely short "data flow" function, Short-Term Memory serves a "recollection-remembrance" function. This memory operation tends to retain general features of recently received information while often allowing the details to be lost. However, attention directed to retaining these details aids this mechanism to remember them as well.

The capacity of the Short-Term Memory is relatively small - apparently limited to 7 ± 2 discrete items (Miller, 1956). However, Miller found that this capacity can be greatly expanded, functionally, by transforming discrete units of data into meaningful conglomerates through operations called "chunking" and categorizing. These operations involve retaining the information over an extended period of time, and so cannot occur in the Short-Term Memory; "chunking" and categorization are operations occurring in the working Memory. In the absence of interference, information can be transformed from the Short-Term Memory to the Working Memory, "chunked," rehearsed and transformed. However, if interference is present, sufficient attention may not be available for this transference and transformation to occur. When this is the case, the information contained within the Short-Term Memory "fades" or "decays" rapidly after only a few seconds, resulting in as much as a 90% loss after only 18 seconds (Broadbent, 1963, 1971; Peterson and Peterson, 1959).

Information reaching this far into the system has already begun a process of transformation or translation into a form which has meaning for the learner. This transformation may produce alterations, incompleteness, inaccuracies, and/or distortions with respect to the originally presented information, so that it becomes more compatible with what the system already knows and/or expects. Unless feedback is received which tells it otherwise, the system will accept this transformed information as being equivalent to the information originally presented by the environment.

8. **Executor.** Before examining the Working Memory, it is appropriate to introduce the Executor. The Executor is the administrator of the entire information processing system. To do its administrative tasks, the Executor operates to:

a. **assign meaning** to recently encountered and received information. This includes influencing the Sensory Receptors, Perceptual Register, and the encoding of data as it enters the Data Transporter. In effect, it assesses, reduces, modifies, and to some degree censors information entering the system (Prokasy and Hall (1963) in Ellis et al., 1979).

b. **assign meaning** to ("making sense of") information in the Short-Term Memory and Working Memory. This includes deciding what this information "means" in terms which the learner can understand (i.e., in terms which "make sense" to the learner.) (Flavell, 1977; Martin, 1971; Postman, 1968).

c. **decide what information will be retained** within the system as well as **how** it is to be used, transformed, retained, and stored. Such decisions involve recently received information as well as information from long-term storage (Greeno in Gregg, 1974).

d. **direct the functioning** of other components of the memory system (i.e., Short-Term, Working, and Long-Term Memories) and their interactions (Krech et al., 1974).

e. **decide how much influence** the learner's Cognitive-Belief System will have in formulating the meanings to be assigned to new and recently received information. It also identified the alternative responses open to the learner (Allport and Postman, 1945; Salomon, 1979; Tulving, 1962).

f. **decide how the learner will respond** within a given environment and situation. The Executor notifies the Response Activator as to which behavior has been decided upon. This message identifies the type and kind of response to make in the given situation (Ellis et al., 1979).

g. **direct the internal thinking operations** within the system responsible for conscious thought, processing, and related activities (Cofer, 1973; Berelson and Steiner, 1964).

In summary, the Executor directs the inner functionings of the memory-storage-response system, which in turn, ultimately controls what is learned, how it is stored, and how one will respond. As a general rule, the Executor is greatly influenced by previous experiences as these have been encoded in the learner's own Cognitive-Belief System. Hence, there is an overwhelming tendency to perceive and transform new information so as to fit the individual's existing "world view." Decisions as to the relevance of information to the learner are made by the Executor within a context established by the Cognitive-Belief System.

The Executor decides what information will be transferred into Working Memory (Crowder, 1976). It also determines how this information will be transformed and handled within this particular memory component. In carrying out this and many of its other functions, the Executor seems to operate outside the conscious control of the individual (Shevrin and Dickman, 1980).

9. **Staying Alive in Memory.** The life span of recently received information within the processing system up to this point has been measured in terms of seconds. Information which is to be "learned" must be retained for much longer periods of time. The longer information is kept "alive" within the memory system, the more likely it will be stored for later retrieval. Therefore the learner must take active steps to extend the "lifetime" of information to be learned. One way in which he can keep information alive is by "rehearsing" it in various ways in conjunction with other new information and with previously--stored information from the Long-Term Memory.

The primary purpose of "rehearsal," or practice, is to enable the learner to understand the meaning, message, intent, value, and/or uses of information in relationship to other information already or just being processed. Extensive rehearsal takes place within Working Memory, which allows interaction between the Short-Term and Long-Term Memories. During this operation, the information as transformed is being personalized and further internalized in a form which makes personal sense to the learner (Wittrock, 1979; Salomon, 1979).

10. **Working Memory.** Working Memory provides the arena in which newly received information actively interacts with information obtained from the Long-Term Memory (Wittrock, 1979; Shifflin and Geisler, 1973). This interaction tends to "field test" the new data to determine how it might fit into the Long-Term Storage-and-Memory system. The greater the apparent consistency of the new information with long-term memories, the more likely it will be found meaningful and hence be filed for rapid retrieval in Long-Term Storage. The solution of problems through the application of information from Long-Term storage and of recently received information takes place within the Working Memory.

Information reaching Working Memory includes that recently received information which has been kept alive for further processing through rehearsal. At this time, information tends to be further transformed into the types of data which has meaning for the learner in light of previous understandings and experiences (Greeno, 1973; Lindsay and Norman, 1972; Gagne, 1976). If there is a need to retain this information in Long-Term Storage in the form in which it was originally received, then this rehearsal is referred to as "memorizing." However, the most common tendency of Working Memory operations is to transform the new information into "impressions" or "generalizations" which the system equates with the originally given information (Wittrock, 1979; Neisser, 1976).

11. **Consolidation and Storage.** An "attention span" is the period of time during which information contained in the Working Memory is held before it is sent into Long-Term Storage or is "unloaded" from the system. The "attention span" varies across learners and across situations for the same learner (Posner, 1969). The length of these spans appear to be unconsciously regulated, possibly by the Executor. At the termination of a span, information is either encoded and stored in Long-Term Storage for later retrieval, or it is 'dropped' from the system as if it were never encountered.[3] The more important it is for the newly received information to be retained for later use in thinking, the more necessary it is for consolidation to occur before the attention span ends.

Under certain conditions, individuals are capable of carrying information over from one span period to the next. This ability gives the appearance that the Working Memory component has "elastic qualities," i.e., it acts as though it has "stretched" its capacities to accommodate information processing across attention span periods.

The learner does not consciously control what will be stored nor how it will be retained. However, the learner can influence the likelihood of the storage and later retrieval of the information by performing operations designed to achieve the conditions listed below. Information is more likely to move from Working Memory into Long-Term Storage,

a. the more meaning the system has attached to that information,
b. the more it has been appropriately transformed and rehearsed,
c. the more it relates to other information already in Long-Term Memory either by comparison or by contrast, and
d. the greater the "quality" of the consolidation which takes place immediately prior to the close of the "attention span."

Unless motivations and perceptions function otherwise, the results of the encoding-to-storage operation tend to support previous generalizations and impressions (or schemata) which the learner already possesses, while tending to store specific details in cognitively remote locations (Conrad, 1964; Sachs, 1967). In most situations where new information has been encountered by the learner, its consolidation in Working Memory is necessary to help ensure its transfer into Long-Term Storage (Bauman and Glass, 1969).

12. **Long-Term Storage.** Long-Term Storage should not be equated with Long-Term Memory. The information contained in Long-Term Storage is extensive, detailed, and somewhat permanent (Loftus and Loftus, 1980). While there is a theoretically limitless amount of such storage space, it seems that once information is stored in Long-Term Storage, there is a great deal that appears to get "lost." A transfer-to-storage operation encodes the data from Working Memory and files it as is appropriate. Such encoding and filing is beyond the conscious control of the learner (Shevrin and Dickman, 1980).

13. **Retrieval and Learning.** Information which can be recovered from Long-Term Storage and used is information which has been "learned." This recovery is required by the definition of "learning," since it suggests that the information is available over time for use in thinking and directing behavior. The degree of stability of this thinking and behaving across time periods is an indication of how well the information was originally learned. This retrieval operation produces information for use by the learner as its need arises in a given situation. Higher forms of thinking-learning all require later retrieval, but this retrieval is **not** restricted to just how much one can recall. These higher forms are characterized by how well the learner can use **retrieved information** to guide thinking and behavior without having to take time to "think about," or re-process, the information before using it. Thinking and behaving guided by the learner's Cognitive-Beliefs are indications of higher level thinking and behavior.

14. **Long-Term Memory.** Long-Term Memory includes that which the learner "remembers about what is stored." This memory component also directs "how" stored information is remembered. This memory component, and not Long-Term Storage, directs the retrieval operations of searching, locating, recovering, organizing and reconstructing information stored in Long-Term Storage.

The data retrieved from Long-Term Storage via Long-Term Memory may be accurate in many details. But frequently, material seems to be fabricated (invented) by the information processing system at the time that the memory reports its findings. Thus, fabricated information is often supplied in place of information missing in Long-Term Storage in order to present a reasonably complete and consistent "memory" (Berelson and Steiner, 1964; Loftus and Loftus, 1980). "Forgetting" (or the failure to retrieve accurate, complete, and/or detailed information from Long-Term Storage) appears to be a failure of the retrieval operation of the Long-Term Memory rather than a failure of the storage system.

15. **Utilizing Retrieved Information.** Both information and instructions for its use in guided thinking are retrieved by the Long-Term Memory. Since this is "learned information," the memory system operations involved in making sense of and thinking through newly received information are learned operations. This learned information and these learned operations are constantly being used in Working Memory to assist the learner to 'comprehend' and to 'personalize' new information. As a general rule, the memory system uses learned information to make the new information compatible with that which is remembered and retrieved via Long-Term Memory. Seen in this way, the degree of "relevancy" assigned to new information depends upon the number and kinds of associations which can be made between this new information and previously stored information.

16. **The Cognitive-Belief System.** The Cognitive-Belief System is generated out of the Long-Term Storage-and-Memory System. It is an organized framework which functions to separate, departmentalize, structure, and develop hierarchial arrangements of the major ideas, guidelines, beliefs, and generalizations which the learner abstracts from and synthesizes about the universe in which s/he lives. These 'cognitive-beliefs' focus on the learner as a person (i.e., the Self) as well as the relationships s/he has with the World-Outside-Self.

The Cognitive-Belief System contains the learner's world-view, values, beliefs, and attitudes, as well as those ideas and generalizations which are used to make sense of personal experiences.

As a general rule, the Cognitive-Belief System operates through the Conservator to influence the entire system in such a way as to cause it to "see" and "understand" things in ways which are consistent with the existing world-view and the perceived Self.

17. **Conservator.** The Cognitive-Belief System exercises its influence toward conformity through the Conservator. This Conservator exerts a strong influence on the Executor and upon Long-Term Memory operations in order to ensure that information is retrieved and/or processed in ways consistent with the learner's previous perceptions and existing world-view. While the Conservator does not control the Executor or the Long-Term Memory, prior reinforcements and repeated similarity in experiences allow these components to be easily influenced by the Conservator. In essence, the Executor is quite "gullible" with respect to the influence exerted by the Conservator. This explains why individuals almost always interpret both new experiences and past memories in such a way as to produce conformity with their present world-views.

18. **Influence on Behavior.** Not only do previous learnings and the Cognitive-Belief System influence thinking within the Working Memory, they also provide the Executor with data about alternative or needed behavioral responses and/or performances. This information informs the Executor, which then uses the information in order to reach a decision. Should the situation and the content of the information call for a habitual pattern of response or for routine behaviors, the Executor allows existing Cognitive-Beliefs and Long-Term Memories to operate with a relatively open, automatic hand in directing the response. Learned information may also be used to influence what is attended to, selected, and/or rejected during the early stages of the processing operations.

19. **Response Activator.** The entire nervous system functions as the Response Activator in responding to a given situation. This component receives orders from the Executor as to what the response will be and then directs the various physiological systems (e.g., muscles) to carry out the order. The Perceptual Register can also send directives to this Activator, by-passing the Executor by initiating what is called a "reflex action."

20. **Sensory Effectors.** Sensory Effectors are the sense organs, muscles, and other physiological components which respond to the orders transmitted from the Executor by way of the Response Activator.

21. **Feedback-Feedforward.** A behavior or thought generated by the learner is supported or rejected either in whole or in part as a result of the information which is received into the processing system concerning that thought or behavior. If a particular guideline is used in generating that behavior or thought, and if that thought or behavior produces positive results (positive feedback) for the learner, that guideline is likely to be used again in similar situations. Negative results provide 'feedback' as to what did not work, as well as 'feedforward' about what probably won't work or should be avoided in the future. Information derived from the environment's responses to the learner's behavior must be received by the Sensory Receptors and this newly received and processed information begins its journey through the system (Wittrock, 1979).

A Note on the "Ecological Validity" of the SPInPrOM Model

These phases, components, and operations possess "ecological validity" in that they provide a practical and realistic overview of how individuals process information within their natural environments (Neisser, 1976). Findings from empirical research using human subjects and conducted in the natural environments of the learner support the model. Of equal importance is the fact that teacher-educators and teacher-trainees have reported that the SPInPrOM model explains how students as well as they themselves, are likely to think, behave, and learn within and outside classroom settings.

THE DOMAIN OF COGNITION

As shown by the SPInPrOM model, information presented to be learned undergoes a great deal of processing on its way through the system. In some cases, what happens to this information is not what the teacher would like to have happen. Now that these processing events are familiar to the reader, it seems appropriate to introduce a sequence which has more direct application for considering outcome-of-instruction behaviors. This sequence takes the form of a taxonomic system entitled the Domain of Cognition.

The Domain of Cognition includes eight levels of cognitive and cognitive-affirmative thinking and other learning-related behaviors (see Figure 13-2). This Domain also includes two 'pseudo levels' which point out where two crucial learning-related activities take place within this explanation of the thinking-learning continuum. Within this system 'thinking' is defined as "any mental activity" while learning is defined as "acquiring a new thought or behavior which will be **retained, maintained** at a reasonably stable level, and **demonstrated** in similar situations across time." Thinking may result in learning as well as in the incorporation of previous learning, but it is not to be equated with learning. The Domain of Cognition includes pre and post learning levels of thinking which operate within and may result from classroom instruction. One advantage of this taxonomy is that it helps teachers to view the entire range of thinking-learning activities likely to occur during and as an outcome of instruction.

The levels of the Domain of Cognition described below identify the sequence of processing information for thinking and learning from an in-

Figure 13-2. An outline of the major levels and sublevels of the Domain of Cognition.

THE DOMAIN OF COGNITION*

1:00 **PREPARATION**

"OBSERVATION" (input of new information)

2:00 **RECEPTION**

- 2:10 Literation
- 2:20 Recognition
- 2:30 Recollection

3:00 **TRANSFORMATION**

- 3:10 Personalization
- 3:20 Adaptation

"INFORMATION ACQUISITION"
(Encoding and storage of information into Long Term Storage)

4:00 **RETENTION**

- 4:10 Recoginition
- 4:20 Recollection

5:00 **CUEPLICATION**

- 5:10 Replication
- 5:20 Variation

6:00 **TRANSFERSION**

- 6:10 Replication
- 6:20 Variation

7:00 **INCORPORATION**

- 7:10 Replication
- 7:20 Variation

8:00 **ORGANIZATION**

- 8:10 Organization
- 8:20 Personation

*Robert J. Stahl (c., 1981). Arizona State University, Tempe, AZ 85287

structional viewpoint. This taxonomy is not a modification of the Bloom-Krathwohl systems. It is an entirely new system and should be seen as such. And although the Domain of Cognition is related to the SPInPrOM model, the reader is advised not to look for an exact one-to-one correlation between components of these separate models.

Progressing Up the Levels of the Domain of Cognition

The eight levels and two "pseudo" levels of the Domain of Cognition are presented below in sequence from the lowest to the highest levels. The Domain of Cognition can be used as a 'model of thinking' with reference to types and sequence of Cognitive operations and a 'model of educational outcomes' describing specific behaviors which may result from instruction. These levels are described below in terms of educational outcomes. (See Figure 13-2).

Level 1:00 PREPARATION. Preparation is defined as those behaviors which demonstrate that and/or how an individual is expecting, ready to act on, or ready to receive information and experiences about to be presented to him/her in a given situation. The behaviors at this level demonstrate the readiness or expectations an individual has immediately prior to or at the moment of encountering new information, situations, or stimuli.

First Placebo Level: OBSERVATION. This placebo level is included to indicate where the actual intake of external information occurs within this sequence of thinking-learning. This level is added for completeness. Information not taken in or "observed" via the senses is not available to the learner for later processing, thinking, or learning.

Level 2:00 RECEPTION. Reception is defined as those behaviors, events, and test situations which demonstrate that information immediately available to or that has just been made available to the individual has been taken in (i.e., mentally received) by the individual in much the same way it was presented. The individual gives evidence that information was taken in near verbatim form as originally given with no intentional effort to change the form, meaning, or content of the information. These behaviors include evidence of remembering information which was just presented to or which was newly thought of by the individual within a short time frame of a class period, experience, or situation. Hence, remembering information for a few seconds, a few moments, an hour or two and recalling it would be evidence of this level of behavior.

Level 3:00 TRANSFORMATION. Transformation is defined as those behaviors, events, and test situations which demonstrate how an individual has revised, modified, or given meaning to verbatim information just received. In essence, the individual demonstrates how he/she has comprehended or translated recently received information into terms, phrases, uses, or actions which give evidence of the sense (or meaning) the information has for that individual from his/her own perspective. Thus, the individual uses behaviors which demonstrate "this is what this information

means to me."

Second Placebo Level: INFORMATION ACQUISITION. This second placebo step in the sequence operates beyond the conscious control of the learner. Added for completeness, this step identifies where the acquisition, encoding, and storage or recently transformed information from Working Memory into Long-Term Storage following the close of an "attention span" occurs.

Level 4:00 RETENTION. Retention is that level at which the learner demonstrates the ability to search for, locate, and recover information stored in long-term storage via long-term memory. This ability to recover information when necessary from long-term storage provides evidence that learning, at least at minimal level, has occurrred. (Note: As pointed out in the SPInPrOM Model, information received by the learner during a given class period and recalled and used from the short-term and/or working memories is not evidence of successful learning. Learning is dependent upon retrieval from long-term storage--a phenomenon which cannot be measured during the class period in which the information is first received.)

"Recognition" is the lower of the two sub-levels of retention. Recognition behavior requires the learner to retrieve sufficient information to enable her or him to decide whether a particular set of data has been experienced previously (e.g., multiple-choice or matching test items). On the other hand "Recollection," the other sub-level, requires the learner to recover information form storage in order to complete or fill in gaps of missing data (e.g., completion or fill-in-the-blanks test items).

Level 5:00 CUEPLICATION. Cueplication is defined as those behaviors, events, and test situations which demonstrate that the individual **can use** (or, **can apply**) principles, rules, etc., given 23 hours or more earlier in current situations or to problems when he/she is directly instructed (or 'cued') to use that particular principle, rules, etc., in that circumstance. On this level, the individual's decision to use a particular principle or rule is directed by some external source regardless of whether the individual could 'read' the signs embedded in the problems or situation which also serve to cue him/her as to what principle or rule is to be used.

Level 6:00 TRANSFERSION. Transfersion is defined as those behaviors, events, and test situations which indicate that the individual **will apply** principles, rules, etc. given 23 hours or more before to current situations or problems without any external source directing him/her to use particular information in that circumstance. On this level the individual on his/her own (1) "reads the embedded cues" given in the problem or situation, (2) recalls the appropriate principle, rule, etc. without outside direction, and (3) voluntarily applies this information in resolving the problem or situation.

Level 7:00 INCORPORATION. Incorporation is defined as those behaviors, events, and test situations which indicate that the individual applies in an automatic, almost habitual manner principles, rules, etc. to problems or situations where its use is seen by the individual as appropriate. To achieve this level, the individual has previously rehearsed the use of a particular principle, rule, etc. so often that its application to a problem or situation is now automatic. In other words, the behavior has become a habitual thought pattern, idea, response such that the person never really consciously considers what is guiding his/her behavior at that time. For example, the instant that one no longer consciously pays attention to all the steps in driving a car but does in fact drive the car by habit, this level of behavior has been achieved. Such behavior required the application of practical information as demonstrated via spontaneous behaving as a result of prior practice. On this level, the individual has a more internalized grasp of the information in this "abstract" nature.

Level 8:00 ORGANIZATION. Organization is defined as those behaviors, events, and test situations which reveal how the individual has arranged, organized or prioritized information as part of his/her cognitive-belief system. Behavior at this level is the individual's expression of how his/her own ideas, beliefs and understandings fit into his/her cognitive-belief system as an organized system. This behavior required the individual to give evidence of how particular principle, beliefs, values, rules, etc. are structured within the framework of his/her existing cognitive-belief system.

One of the more unique features of the Domain of Cognition is its avoidance of the use of specific processes (e.g., Application, Analysis, and Synthesis) as the basis for determining which are the "higher" and which are the "lower" levels of thinking and learning. The findings in cognitive psychology reveal that the level upon which thinking and behavior occurs is related to the degree to which one has internalized and uses rules to guide thinking. It is **not** the process itself which determines the "highness" or "lowness" of the level of thinking; rather, it is the level one has acquired and internalized the rules which one uses to guide the various processes which determine the appropriate level of one's thinking (Segal and Stacy, 1975).

Consistent with this research literature, the Domain of Cognition describes a sequence of degrees (or levels) to which information and rules may be internalized and used by the learner. Figure 13-3 illustrates 21 separate mental operations or ways which individuals may use rules in thinking and responding. Each mental operation or **uniprocess** represents a distinct way the learner can make use of rules or guidelines which have been acquired. So-called "complex processes" or **megaprocesses** are defined as 'complexes' or combinations of uniprocesses which are used to respond to a single situation or problem.

Therefore, it is possible for learners to use the same uniprocess on any one of several different

Figure 13-3. The twenty-one uniprocesses.

UNIPROCESS NAME	MAJOR ACTIVITY OF THE UNIPROCESS	FUNCTION OF THE UNIPROCESS[1]	COMPLEMENTARY ACTIVITIES
1. Association	Associating	joining or tying two or more items together with the emphasis on the conjunctive aspects rather than on the whole	Affiliating, Connecting, Interrelating, Relating, Tying
2. Classification	Classifying	forming groups and/or putting items into categories	Categorizing, Grouping, Ordering, Sorting, Systematizing
3. Combination	Combining	putting separate items or information into some single whole	Blending, Chaining, Compiling, Integrating
4. Comparision	Comparing	identifying what and/or how items are similar to and/or different from one another	Contrasting, Equating, Likening
5. Condensation	Condensing	producing a shortened version of some longer form of information	Abbreviating, Abridging, Consolidating, Simplifying, Summarizing
6. Conversion	Converting	changing the external or internal features, size, etc. of an item or information for the purpose of making it different	Altering, Changing, Deviating, Modifying, Revising
7. Description	Describing	reporting the features, number, etc. of the external aspects of information or an item	Announcing, Narrating, Reporting
8. Designation	Designating	assigning a label, name or exactness to an item	Naming, Defining, Labeling, Specifying
9. Discrimination	Discriminating	treating items or information differently from one another	Differentiating, Discerning Distinguishing
10. Extension	Extending	providing information which would likely fill a void in the information which is available or being considered	Appending, Concluding, Conjecturing, Estimating, Projecting, Completing
11. Extraction	Extracting	taking apart or away from a larger whole to focus on its parts and their relation to each other and/or to the whole	Abstracting, Analyzing, Assuming, Deriving
12. Interpretation	Interpreting	making sense of information in terms of the meaning it has	Conceptualizing, Opining, Perceiving, Personalizing
13. Organization	Organizing	putting spearate items together in some interrelated order or sequence with the stress on the interrelationships as well as the order and system	Adjusting, Arranging, Assembling, Composing, Sequencing, Structuring, Systematizing
14. Proposition	Proposing	suggesting or providing a probable way of dealing with a situation or problem	Hypothesizing, Planning, Recommending, Theorizing
15. Reconciliation	Reconciliating	putting apparent opposition items or information together so that they form a compatable or consistent whole	Accommodating, Arbitrating, Balancing, Compromising, Conforming, Equalizing
16. Selection	Selecting	making a preferred, imperative, or needed choice	Choosing, Deciding, Determining, Judging, Picking
17. Separation	Separating	taking apart information and/or a whole to identify its distinct individual parts with the focus on the spliting of the parts from each other	Breaking, Disconnecting, Disuniting, Dividing, Segregating, Severing
18. Translation	Translating	putting information into a different form or version than it was originally given without deliberately changing its message, meaning, or intent	Coding, Decoding, Defining, Paraphrasing, Restating, Simulating, Substituting, Symbolizing, Transforming
19. Utilization	Utilizing	demonstrating how information or an item could be, is being, or has been put to use	Applying, Employing, Fitting, Transferring, Using
20. Valuation	Valuating	assigning value, a rating, or priority to an item or information	Appraising, Appreciating, Assessing, Evaluating, Judging, Prioritizing, Ranking, Rating
21. Verification	Verifying	specifying how information has been or is to be accepted as valid, true, reliable, or accurate	Authenticating, Confirming, Proving, Substantiating, Supporting, Validating

[1]Functions listed are illustrative and are not to be treated or considered as inclusive.

Note: The numbers are nominal and do not represent order of priority or importance.

levels of thinking and learning (i.e., Transformation, Cueplication, Transfersion, Incorporation, and Organization). Teachers must learn to focus their attention on helping learners increase the degree to which they internalize rules which can become the basis for higher levels of thinking. They must also abandon their belief that it is the process itself rather than the degree of the internalization which determines whether an outcome is the result of a "higher" level of thinking and behavior. Finally, teachers should consider the act of "processing" information as equivalent to "rehearsal time," during which the learners are practicing putting the rules and guidelines to use, thus increasing the likelihood that these rules will be acquired and further internalized.

The above represents a brief description of some of the major features of the Domain of Cognition. Preservice and inservice teachers at Arizona State University are currently using this taxonomic system as a basis for identifying and writing specific behavioral/instructional objectives. They are also developing test items for measuring the various outcome behaviors associated with these different levels. With these uses and attributes, the Domain of Cognition represents an important new addition to the field of teacher education and is a viable alternative to the taxonomic models presently being used.

SOME PRINCIPLES OF LEARNING AND THINKING

In reflecting upon the SPInPrOM and the Domain of Cognition models described above, the following list presents useful principles for instructional designers and teachers to consider in planning for and assessing the outcomes of instruction:

a. The individual learner is confronted with so many specific details in the environment that it is a wonder that as much detail is eventually stored in and retrieved from Long-Term Storage as in fact is (Deese and Hulse, 1967).

b. The processing system has a general tendency to deal with and produce generalizations and impressions of what information was received, rather than to retain the specific details of this information (Crowder, 1976; Kolers, 1974; Sachs, 1967).

c. A learned behavior is impossible to confirm at the time new information is first encountered, even though one's performance might suggest otherwise. The classroom teacher should follow the general rule of waiting 24 hours until the next class period begins before attempting to measure what can be **retrieved** and used via Long-Term Memory. This 24-hour period has precedence in learning-memory research. (Postman and Rau, 1957; Deese and Hulse, 1967). Learned behavior **cannot** be demonstrated during the class period in which information exhibited by this behavior was first received.[6]

d. There is no inherent difference between information useful for guiding cognitive thinking and learning (e.g., geometric theorems) and information useful for guiding affective thinking and learning (e.g., reasons for making moral decisions). It is the society, culture, institutions, etc. which attach special meaning to such information and give the appearance that values, moral beliefs, and affective, and/or normative-oriented information do possess inherent qualitative features. The learner actually deals with cognitive guidelines (e.g., how to read a map) the same way as affective guidelines (e.g., do unto others as you would have them do unto you) within the information processing system.

e. The learner continually uses and is influenced by information and understandings from her/his own Cognitive-Belief System and Long-Term Memory, which in turn operate to assist her/him to transform, select, make sense of, and assign meaning to new experiences and data (Samuels, 1974). By and large, the entire information-processing system tends to translate new information and experiences in such a way as to make them conform to and compatible with one's existing Cognitive-Belief System and Long-Term Memories.[7]

f. The individual uses rules as the basis for guiding his/her thinking and behavior. The critical role rules (or guidelines) play in psychological processing must be understood by teachers (Segal and Stacy, 1975). Rules or guidelines also provide the basic explanations, reasons, and basis for behavior (i.e., one behaves because of the operation of certain guidelines at the time of his/her behavior) (Katona, 1940; Postman, 1954; Segal and Stacy, 1975; Zeiler, 1963).

g. The use of a rule or guideline by a student does not necessarily mean s/he can identify (at least beforehand) what the rule is (Erickson and Jones, 1978; Wason and Evans, 1975). At the same time, recalling or stating a rule does not necessarily mean one understands it nor can use it (Erickson and Jones, 1978). Furthermore, the learning of information as information is different from learning information as guidelines and using it in this way (Gagne and Briggs, 1974).

h. The individual tends to apply a given guideline only in those situations which contain certain **specific** cues which

were originally associated with that guideline during its learning. The more these cues and situations appear in association during initial rehearsals and the more the individual is reinforced for using the guidelines with these and only these cues, the less likely the individual will be able to **transfer** these guidelines to new situations at later times (Berelson and Steiner, 1964). Transfer of learning implies the transfer of guidelines originally associated with one type of situation to other situations where their use is appropriate but not necessarily previously evident to the individual.

i. The consistent and sometimes contradictory research findings related to the effects of external cues, stimuli, and reinforcers suggest very strongly that the effects of these external variables are learner-determined and not externally determined (Wittrock, 1979).

j. The individual learner operates frequently on two different "levels" of thinking and the processing of information. The retrieval and use of information via Long-Term Memory for use in working with recently received information represents higher level thinking while mental activities utilizing only recently-received information represent lower-level thinking.

The SPInPrOM model and the Domain of Cognition are supported by extensive findings related to human learning research and possess ecological validity from the perspective of in-service and pre-service teachers. These two systems are compatible with a wide variety of apparently divergent schools of psychological thinking. Both also represent feasible models for differentiating among the internal aspects of memory, thinking and learning. Both models also lend themselves to explaining external behaviors as they are occurring and as they may be identified as outcomes of instruction. Finally, these models are "teachable" within the framework of teacher education programs, and they are "learnable," especially SPInPrOM, in that inservice and pre-service teachers are able to understand and use them, within a very short period of time.

MOVING FROM TAXONOMIC LEVELS TO IDENTIFYING INSTRUCTIONAL OUTCOMES

The Domain of Cognition was originally developed as part of an entirely new framework for use in planning, implementing, and assessing instruction which would be appropriate for all content areas and grade levels (Stahl, 1978). This framework provides a logical and sequential series of steps leading from the identifying of a unit focus to the specifying of relevant terminal, performance objectives. Within this system, the Domain of Cognition is to be used to identify specific behavioral outcomes of instruction much as the Bloom-Krathwohl models are being used at the present time. However, the components of specific objectives are somewhat different than those proposed by Mager (1962) and others. At the same time this new taxonomic model can be used within existing curriculum and/or evaluation systems. (See attached footnote).

To appreciate the role of this taxonomy and the value of planning instruction and writing specific objectives within the new approach proposed by Stahl (1978), a brief overview is provided below.[8]

The teacher starts the unit with a specific idea, generalization or principle that is identified as the single most important knowledge students are to acquire, comprehend, and utilize as a result of all the instruction during the unit. Put in another way, this "focusing statement" is the single most important understanding students are to achieve even if they were to forget all the specific data introduced during the entire unit. An example of a usable focusing statement is:

> "As individuals or groups move into a new territory, their lifestyle and the lifestyles of those who are already there are likely to change."

Once the unit focus is specified, the teacher begins to extract from the idea the kinds of information students will or may need to know in order to fully comprehend this single statement. As the process takes place, an extensive list of 50 or more "learning needs" is identified for the unit. Some "learning needs" generated from the focusing statement above include:

a. What is meant by a lifestyle?
b. How can lifestyles change?
c. Who determines what changes will take place?
d. How can individuals or groups move into a new territory?

(Following the guidelines for generating "learning needs," this list could easily exceed 50-75 separate items.)

One of the outstanding features of this listing is that it identifies no specific subject-matter content other than that included in the original focusing statement. As one might have already noticed, the focusing statement above could be used in any number of social studies units across any number of nations or ages, and it could fit many behavioral and biological science courses as well. In specifying learning needs, the focus is on "milking" the unit focus for as many separate need statements as is possible.

The extensive list is then "weeded" in order to idenfity the four to six most important learning needs to be stressed in the unit. These remaining learning needs are then converted into general instructional objectives by rewriting them in the appropriate language for such objectives. Thus, from the list cited above,

"How can lifestyles change?"

becomes rewritten as a general instructional objec-

tive,

> "At the end of the unit, students will understand how lifestyles can change."

Following this procedure, all of the general objectives for a unit will identify important learning outcomes and are relevant to one another, since they all are generated from the same central focus. At the same time, these general objectives are usable in different units over a wide variety of content areas.

At this time, the teacher begins to identify what specific subject-matter learnings the students are to acquire. This procedure results in two types of basic information. The first includes guidelines students are to comprehend and learn how to use (e.g., a description of six ways in which lifestyles can change). These guidelines then will become the basis for guiding uniprocesses and megaprocesses within the various levels of the Domain of Cognition. The second type of information includes the specific facts that students are to acquire and are to be able to recall at a later time (e.g., the names of five Indian tribes, the date Jamestown was founded, the title of Alex Haley's best-selling novel).

Since guidelines can be learned at the Transfersion, Incorporation, and Organization Levels of internalization, the planner must decide which level is appropriate and reasonable to expect the student to achieve for the given guideline in the length of time allowed for instruction. An example of a specific objective for this unit would be:

> When given an example of cultural change not previously studied, the student will correctly identify, in written form, the way the lifestyle changed, using the description of six ways in which lifestyles can change, as given in class, as the basis for their answer. (TRANSFERSION: REPLICATION)

This specific objective requires that the final student response to the situation make use of information included in the particular unit. Specific objectives written on the Retention Level stress the identification of content data to be retrieved and revealed in the form in which it was originally given or stored. An example of a specific objective on the Retention Level might be the following:

> When presented with a 30 item multiple-choice test on examples of change occuring in lifestyles throughout American history, the student will mark at least 22 answers correctly as determined by citations, handouts and the text. (RETENTION: RECOGNITION)

The procedures outlined above are to be repeated until all of the major guidelines and facts for the unit are incorporated into appropriately written specific objectives.

Specifications for Writing Specific Instructional Objectives

Within the instructional design system outlined by Stahl (1978), the specifications for writing specific objectives are not the same as those advocated by Mager (1962). As has been done previously in this chapter, rather than compare these two procedures, this section will explain in detail Stahl's approach to the writing of specific objectives.

The four components of each specific instructional objective are:

a. the **condition** or circumstances,
b. the **specific behavior**,
c. the minimum acceptable **performance level** of the behavior, and
d. the **criterion** used as a standard against which to determine correctness

Each component is a distinct and important component in its own right. The construction of each component requires the mastery of specific skills directly related to it alone. These components will be described in a somewhat different order than that in which they were identified above for the sake of convenience.

The Specific Behavior

The specific-behavior component identifies the exact activity or product that the student is to demonstrate as an indicator of what has been learned. This component must be stated in terms of observable and measurable behaviors which are **equally noticeable to both** the student and the teacher. This component states exactly what it is that students will be doing or will do in order to show what new behaviors they have learned. A behavior that can be sensually experienced (seen, read, heard, touched, tasted, or smelled) by the teacher must be identified.

Here are two examples of statements which describe what a student must do in order to demonstrate learning:

a. The student will describe Impressionistic Art.
b. The student **will identify in writing** five ways a painting by Monet demonstrates the characteristics of Impressionistic Art.

Statement a indicates only that the student will "describe" Impressionistic Art. But what does this indicate that the student knows? Can do? Is to do? How can the teacher determine whether the student has correctly and/or fully described this area of art? The general behavior "describe" is neither observable nor measurable. More than likely, different individuals will interpret "describe" in very different ways. Hence, when and how will the student or the teacher know when this objective has been reached? On the other hand, statement b leaves no doubts as to what is expected and required of the student. It states exactly what it is students will be doing or will

have to do. Note that the behavior specifies "in writing," since merely to "identify" by itself still lends itself to several interpretations as to what **exact behavior** learners will have to show in order to prove they can "identify." Also, to "identify" does not describe a behavior specifically detectable by the sense organs as does "in writing," since what the student writes can be **seen and read.** In conclusion, unless a statement identifies and describes the exact behavior or product which can be seen, read, heard, touched, tasted, or smelled, it is not exact or specific enough.

To master this component, it is suggested that each statement of this component include a **demonstrative verb phrase** which identifies the observable behavior that is expected as a learning outcome. This verb phrase specifies the exact behavior or product that an observer can witness and measure. The following action verbs are commonly cited as being suitable for stating specific objectives, but must be used with caution:

relates	formulates
specifies	predicts
distinguishes	explains
describes	identifies

The reader is cautioned **not** to use such action verbs in specific objectives. While these verbs generally describe certain behaviors they do not specify exactly what students are to do. For instance, how are students to show that they can formulate, specify, or distinguish? However, these action verbs may be used to develop demonstrative verb phrases which are very specific in the behaviors they identify. The following examples show how the teacher may modify action verbs in order to specify exact learning outcomes:

The student **will describe orally...**

The student **will explain in writing...**

The student **will identify by labeling** in writing...

The student **will, in written form, identify** the relationship between...

The student **will write** a synonym for the term "conflict"...

The student **will select and circle** the correct answer from among those given...

The student **will match and then mark** an event with its appropriate date of occurrence...

These types of demonstrative verb phrases specify more exactly the behaviors to be shown than do the action verbs provided earlier, which identify only general behaviors. The above examples provide only a sample of the type of language which must be used in specifying the behaviors required in this component of a specific objective.

The Performance Level

The performance level identifies the exact level of competency which the students' behaviors are required to display in order for them to be judged as providing acceptable evidence of learning. This component identifies the acceptable minimum standard of achievement for the particular content or behavior stated in the objective. The performance level states the degree of completeness, accuracy, or correctness which will be the lowest acceptable indicator that sufficient learning has taken place. For example, examine the following objective:

> "Given ten recipes which they have not seen before, five of which are of Spanish and five of Mexican origin, the students will correctly identify in writing which of those recipes are of Spanish and which are of Mexican origin..."

Does this statement identify a minimum level of performance? While it states a behavioral expectancy, it does not identify how many recipes the students must get correct in order for them to demonstrate a minimum acceptable level of learning for this objective. To fit the requirements for this component, the objective must state how many or what percentage of the recipes the students are to correctly identify. While one could assume that the required level of performance is all ten recipes, or 100% correct, this assumption does not allow the teacher to drop this performance-level indicator from the objective. Hence, a correctly-stated component would be similar to one of the following examples:

> ...the student will correctly identify in writing with 100% accuracy the five Spanish and five Mexican recipes...
>
> or
>
> ...the student will correctly identify in writing all five Spanish and all five Mexican recipes...

As suggested, to merely say that students will "correctly identify" does not say enough about the exact performance level expected. What does "correctly identify" mean? When one states "with 100% accuracy" or "all five Spanish and all five Mexican recipes," there is no doubt as to what is expected and what will be accepted.

In other specific objectives, the performance level may be identified by stating the minimum number of behaviors which are expected. For example:

> ...the students will correctly label 11 of the 13 colonies...
>
> ...the students will state in writing three ways in which Greek and Roman Art were similar to and two ways in which they were different from each other...
>
> ...the students will circle correct answers to 18 of the 25 multiple choice items...

As can be seen, these examples identify the minimum standard of achievement which is to be demonstrated by students at the end of the unit.

The Condition

The "condition" component identifies the exact circumstances, givens, or stimulus which will be imposed on or presented to students when (and while) the specific behavior specified by the objective is to be demonstrated. This component states under what conditions or circumstances the students will have to work at the time the behavior is to be demonstrated. Thus, it may state what time, materials, or other limits are to be given or imposed on the student. It may include what tool(s) and/or material(s) are to be provided, excluded, or are needed by students for them to demonstrate their level of learning. The "conditions," like the "specific behaviors" and the "performance level," must be specified in exact terms, so that the precise circumstances or givens which are to be presented to students during testing are identified prior to the start of the unit.

The examples which follow illustrate the forms that the **conditions** component most often take:

> Given a list of...
>
> When asked to do so on an in-class written assignment...
>
> When given problems on the board...
>
> Given two poems of the Romantic Era...
>
> When called upon to do so...
>
> Given two paintings by Dali which they have not seen...
>
> Given a series of matching test items on the Middle Ages...
>
> When presented with a design problem...
>
> When given a problem which requires the use of the principles of management...

Statements of conditions emphasize what the learner will be provided or what circumstances will prevail while the learned behavior is being demonstrated.

None of these components of the objective automatically suggest a higher level of thinking or learning. Nor do they automatically tie in with one single level of taxonomic behavior. As with the other components of a specific objective, this component interrelates with the others to produce a single statement which does indicate a specific level of thinking, learning, and behavior.

The Criterion

The "criterion" component identifies the exact information which students are to use as the basis or guideline for the behaviors they are to demonstrate. It is well known that students may often be able to answer questions or complete assignments correctly by using information and procedures which are not included in the unit they are studying. As they do so, students may be given credit for achieving the mastery of objectives which they have not mastered as a result of studying the present unit; this occurs because of the correctness of the final answer. For instance, students may be able to interpret a poem at the end of a unit by using previously-learned rules relevant to poetry interpretation. Yet teachers should expect students who studied a poetry-interpretation unit to interpret the poem in ways that those who had not studied the unit would not be expected to use. Hence, the teacher would expect and should insist that students explain, defend, or base their interpretations upon the information about poetry interpretation which was **studied in class** during that particular unit. To this end, it is the interpretation **together with** the basis for this interpretation which demonstrate whether or not real learning has taken place.

According to this approach to planning and evaluation, students should not be given full credit for only their answers, they should only receive full credit for behaviors which **give evidence that students have learned what has been taught in the unit they have completed.** In other words, they should receive credit only for their ability to base their responses upon the information, principles, guidelines, etc. studied during that unit of instruction. Subsequently, the accuracy and correctness of the students' responses and behaviors must be based upon the use of those learning outcomes stressed in their unit and its lessons. This requirement is offered in contrast to the practice of assessing students' responses and behaviors only in terms of their immediate correctness, regardless of the how or why of the responses.

The reasons for this requirement should be clear. If indeed the information, principles, guidelines, etc. are important enough to be taught, they are important enough to be used as the grounds upon which to measure and assess student achievement. Also, the information, principles, and guidelines are in themselves valuable because they may allow students to develop ways of thinking and procedures for dealing and copying with a wide variety of situations and problems. On the other hand, any one single problem or question may be responded to through trial-and-error or guessing behaviors which may have little or no applicability to other, similar problems. Therefore, merely giving full credit for correct answers does not tell the teacher whether students have really acquired the essential information, principles, guidelines, etc., which were stressed in the unit.

To help guarantee that information stressed in the unit is used as the basis for the behaviors demonstrated at the end of the unit, the teacher specifies these learnings in the **criterion** component of the specific objective. This statement identifies the grounds, reasons, or information source which is to be used to accurately assess the students' behaviors. In the example below, note the way in which the criterion identifies what it is students are to use in order to demonstrate that their answers are based upon the content studied in the unit:

> Given two dramas by Shakespeare, the students will write an essay which correctly states at least six ways in which these dramas are similar in their development of the major character, **using the guidelines for character development discussed in class** as the basis for their comparisons.

In this example, the criterion component states very specifically what is to be used as the basis for the response, i.e., "the guidelines for character development studied in class." This required behavior ensures that students do not invent characteristics or features as a result of the immediate test problems, but which are largely a product of test anxiety, guesswork, trial and error thinking, etc. To help guarantee that students are indeed using what they are supposed to have learned, the teacher includes in the specific objective the source to be drawn upon in arriving at correct and acceptable behaviors.

Criterion statements are often stated in terms of some of the wording illustrated by the following examples:

> **...according to the procedures** of parallel parking demonstrated in class.
>
> **...based upon the principles of design given in the text and in lecture notes.**
>
> **...using the guidelines** for developing effective team play as **outlined in the movie.**
>
> **...using the rules for solving quadratic equations as stated in the textbok.**
>
> **...based upon the criteria** for effective paragraph construction as **given in the handout.**
>
> **...according to the characteristics** of classical music **identified in class.**
>
> **...using six of the ten elements** of literary criticism **which were stated in class** as the basis for their response.

In these examples, the criterion component clearly identifies what it is that students are to base their responses upon. It also identifies what it is that teachers are to use as a criterion for measuring the degree to which learning has occurred. Importantly, the higher the taxonomic level of the specific behavior, the more the teacher must insist that students use the stated criteria as the basis for guiding and assisting their thinking and behaviors. Furthermore, since the major thrust of higher level learnings is upon principles, guidelines, and rules students are to comprehend, retrieve, and use, the teacher must ensure that the focus of the evaluation of the students' performances at the end of the unit are the very same principles, guidelines, and rules which were studied in the unit.

Putting It All Together

To review, well-written specific objectives include four separate and distinct, yet interrelated, components. In the order in which they are usually written, these components are:

1. **The Condition.** This identifies the specific givens, circumstances, conditions, or stimuli which will be provided or presented to the students prior to, at the start of, and/or during the performance of the specific learned behavior expected at the end of the unit.
2. **The Specific Behavior.** This identifies the precise, exact behavior to be demonstrated by the students and which will be accepted as indicative that students have achieved the appropriate learning level.
3. **The Performance Level.** Often interrelated with the specific-behavior component, this identifies the minimum level of performance or behavior which will be accepted as evidence that the students have achieved a sufficient level of mastery of the material.
4. **The Criterion.** This identifies the basis, grounds, or information source which students are to use in arriving at, supporting, explaining, and/or justifying their behaviors and which teachers are to use as the criterion for determining whether or not students have attained the major information stressed in the unit.

SUMMARY

This chapter has sought to introduce a new orientation for planning, implementing, and assessing instruction. The Stahl Perceptual Information Processing and Operations Model (SPInPrOM) was proposed as a model of how thinking, memory, and the processing of information take place within the individual learner. The Domain of Cognition was introduced as a system for identifying the sequence of thinking and processing likely to result in several different levels of learned behaviors. A rationale for building the taxonomic scheme upon the degree of internalization of rules or guidelines rather than the assumed "higher or lower level" processes was given.

The role of the Domain of Cognition within the instructional design framework developed by Stahl (1978) was illustrated by examples of the several sequential steps making up this system. Included within this framework are procedures for setting up specific insturctional objectives tied to the information stressed during the unit of instruction. Specifications for writing these objectives were presented.

This chapter was intended to be introductory and descriptive. It was designed to introduce readers to a number of new ideas, models and procedures directly related to instructional design. Rather than concentrate upon a comparative analysis of this approach with existing models, it seemed appropriate to provide more details, so that the readers could proceed to make compar-

isons relevant to their own interests and needs.

Finally, the models and procedures outlined here are "teachable" to undergraduate and graduate students in teacher-education courses. They have been and are being used to design, plan, implement, monitor, and assess instructional units across a wide variety of content areas. As such, they represent a pragmatic approach to converting research findings into practical procedures for improving instruction.

FOOTNOTE

For those who may desire a more specific comparison between the behavioral objectives format proposed by Mager and that introduced here, the following is provided. Both Mager and Stahl include the necessity of stating the **conditions** under which the behavior will be expected to occur. Both Mager and Stahl indicate that a **terminal behavior** needs to be specified in exact behavioral terms, but they differ on how this should be stated. Mager (1962, p. 14) states the need to specify "what the learner (is) doing when he is demonstrating that he has achieved the objective." Examples of acceptable statements for Mager include "identify by name" (p.14), "write a summary of..." (p.21) and "solve for the unknown..." Stahl, on the other hand, would argue that further specification is needed for two of these three Mager examples. That is, "identify **in writing** the name" and "**write** the solutions for the unknown" are behaviors which are observable; whereas merely 'identify' and 'solve' imply behavior but tend to stress internal thinking prerequisite to or concurrent with the student's actual behavior. Stahl's format does what Mager's does, and goes one step beyond to specify an actual behavior in each and every case. Both Mager and Stahl advocate the need to specify at least a minimal level of successful performance of the behavior specified. For example, "correctly solving at least 30 of 35 linear equations" would be appropriate for both models, with Mager referring to this component as the **criterion** while Stahl names it the **performance level.** The critical difference therefore is in the fourth component added by Stahl which is nowhere to be found in the Mager approach. Stahl's fourth component, which he labels as the "criterial" or **criterion** component, identifies the standard or source of information which is to used (a) by the student to guide his/her behavioral response and (b) to ensure that this response was guided by learning developed as an integral part of the course/instruction. Hence, a statement like "using the guidelines for interpreting Romantic poetry as given in the text" as the basis for the behavior response is required in the Stahl approach and not mentioned by Mager. The advantages of the 'criterial' component lies not only in specifying the criterion for assessing the actual behaviors of the students but also in that it identifies the important content and learning teachers must stress in their courses in order to insure students can recall and use these to base their responses at the end of the teaching.

NOTES

1. Appreciation is extended to the following individuals who have provided their professional expertise and critiques to the various stages of the written drafts of the models presented herein: Drs. John Bell, Robert Armstrong, Susanne Shafer, William Svoboda, and Nicholas Appleton, and Ms. Blanche S. Hunt and Pam Hronek, all from the Department of Secondary Education, Arizona State University, and Ms. Nancy N. Smith, Ravenscroft Lower School, Raleigh, North Carolina.

2. Lengthy descriptions of the Domain of Cognition described herein are available from the author.

3. The debate as to whether this information is ever "dropped" completely from the system is a moot one. Information which is impossible to retrieve, unless under hypnosis or the like, for all practical purposes is "lost" from the system as far as the teacher is concerned (and probably the learner as well).

4. As presented here, there exist no automatically or inherently higher or lower-level processes such as comparing, and analyzing, etc. In this model, all operations of the Perceptual Information Processing System reveal the processing of information. Uniprocesses are ways in which the individual can work with information in a single, unique way. Uniprocesses include associating, classifying, extracting, and valuating. Megaprocesses are combinations of uniprocesses and include problem solving and inductive reasoning. In this system, it is the level of the source of the information which guides thinking and these uniprocesses and megaprocesses, not the processes themselves, determine whether the thinking is a higher or lower level operation.

5. The Retention Level is equivalent to Bloom's "Knowledge" level. Note that this level in the Domain of Cognition is preceded by three earlier levels which affect learning, retention, and ultimately higher-level thinking. In contrast to Bloom's model, higher levels of thinking-learning will not be tied to any given uniprocess.

6. The reader cannot "learn" the information presented in this or any other paper containing new information at the time it is first read or studied. However, what you can recall and/or use about this paper tomorrow could be used to indicate the <u>minimal level</u> of your learning today.

7. Your use of information presented in this chapter today would represent lower-level thinking (TRANSFORMATION), while similar thinking tomorrow, based upon retrieved-via-

Long-Term-Memory details would be an example of higher-level, or Transfersion, thinking.

8. Copies of the curriculum planning approach, in Xerox form, are available from the author at cost.

9. For those who may desire a more specific comparison between the behavioral objectives format proposed by Mager and that introduced here, the following is provided. Both Mager and Stahl include the necessity of stating the conditions under which the behavior will be expected to occur. Both Mager and Stahl indicate that a terminal behavior needs to be specified in exact behavioral terms, but they differ on how this behavior should be stated. Mager (1962, p. 14) states there is need to specify "what the learner (is) doing when he is demonstrating that he has achieved the objective." Examples of acceptable statements for Mager include "identify by name" (p. 14), "write a summary of ..." (p. 21) and "solve for the unknown ..." Stahl, on the other hand, would argue that further specification is needed for two of these three Mager examples. That is, "identify in writing the name" and "write the solutions for the unknown" are behaviors which are observable; whereas merely 'identifying' and 'solve' imply behavior but tend to stress internal thinking prerequisite to or concurrent with the student's actual behavior. Stahl's format does what Mager's does, and goes one step beyond, to specify an actual observable behavior in each and every case.

Both Mager and Stahl advocate the need to specify at least a minimal level of successful performance of the behavior specified. For example, "correctly solving at least 30 of 35 linear equations" would be appropriate for both models, with Mager referring to this component as the criterion while Stahl names it the performance level. The critical difference, therefore, is in the fourth component, added by Stahl, which is nowhere to be found in the Mager approach. Stahl's fourth component, which he labels as the "criterial" or criterion component, identifies the standard or source of information which is to be used (a) by the student to guide her/his behavioral response and (b) to ensure that this response was guided by learning developed as an integral part of the course/instruction. Hence a statement like "using the guidelines for interpreting Romantic poetry as given in the text" as the basis for the behavioral response is required in the Stahl approach but is not mentioned by Mager. The advantages of the 'criterial' component lies not only in specifying the criterion for assessing the actual behaviors of the students but also in identifying the important content and learning outcomes that teachers must stress in their courses. Teachers must stress these criteria in order to insure that their students can recall and use these sources for basing their responses upon at the end of the teaching.

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